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Genetic studies in vegetable amaranth (*Amaranthus spp*.) under temperate conditions

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Abstract
In the present investigation twenty seven diverse genotypes of Vegetable Amaranth were evaluated for various yield and yield attributing traits. Analysis of variance revealed highly significant differences among all the genotypes under study for all the traits. Range values indicated presence of sufficient genetic variability for all the characters. Phenotypic coefficients of variation were found to be higher than corresponding genotypic coefficients of variation. Most of the traits recorded high phenotypic and genotypic coefficients of variation. All the characters showed the high estimates of heritability coupled with high genetic advance as per cent of mean.

Keywords: Vegetable amaranth, variability, coefficients of variation, genetic advance, heritability

Introduction

The leafy *Amaranthus* is said to be native of India (Shanmugavelu, 1989) [13]. Resembling spinach in appearance, *Amaranthus* leaves come varied in colors ranging from green, purple, red and gold. In India, *Amaranthus* has been recognized as an underexploited vegetable crop with promising economic value and medicinal properties. It is biotic and abiotic stress tolerant with wider adaptability (Lee *et al.,* 2008) [8] and can be grown round the year under varied soil and agro climatic conditions (Katiyar *et al*., 2000 and Shukla and Singh, 2000) [7, 14] except extreme winters. It is also available as non-conventional leafy vegetable in the orchards of Kashmir. The crop is gaining attention of consumers in respect of its nutritional quality. However due to limited availability of cultivars, the crop has not been commercially exploited.

The crop improvement programme largely depends on the extent of variability present. In order to make selection and improvement programmes effective, it is essential to partition the total variability existing in a germplasm into genetic, phenotypic and environmental components. The potential for improvement in crops is proportional to the magnitude of genetic variability present in the germplasm. Heritability has been widely used in determining the degree to which a character may be transmitted from parents to off springs. High heritability along with high genetic advance is important for making effective selections.

Materials and methods

The present investigation was conducted at Urban Technology Park Habak, during *kharief* 2016. Twenty seven diverse genotypes of Vegetable Amaranth were collected from different agro climatic regions of country and evaluated for various yield and yield attributing traits. The single factor experiment was laid out in randomized complete block design (RCBD) with three replications. Standard cultural and plant protection practices were followed to ensure a healthy crop growth. Observations were recorded on various yield and yield attributing traits traits. The data thus generated was subjected to standard statistical procedures.

Results and discussion

Analysis of variance revealed highly significant differences among all the genotypes under study for all traits thereby indicating a good amount of variability in the present material. The genetic variability estimates, heritability (bs) and genetic advance as a per cent of mean are presented in Table-1.

Range values for various characters indicated presence of sufficient genetic variability for all the characters, which is prerequisite for making improvement through selection.

Sufficient variability for number of traits has also been reported by Shukla and Singh, 2003 [15]; Varalakshmi, 2003 [17]. Values of range in various characters reflect the amount of phenotypic variability in those characters, but it is not very reliable since it includes genotypic, environmental and genotype × environmental interaction components and does not reveal as to which character is showing higher degree of variability. Hence, it becomes necessary to split the observed variability into phenotypic coefficient of variation and genotypic coefficient of variation, which ultimately indicates the extent of variability existing for various traits.

Phenotypic coefficients of variation were found to be higher than corresponding genotypic coefficients of variation with slight difference between the values. This indicated that the variability was primarily due to genetic differences and there was little influence of environment in the expression of traits under observation. This was in agreement with the study of Revanappa and Madalageri (1998) [11], Shukla *et al.* (2006) [16] Chattopadhyay *et al.* (2013) [4].

Lateral spikelet length, inflorescence length, leaf area, stem thickness, petiole length, leaf yield ha^{-1}, leaf yield plant^{-1}, plant height, number of branches plant^{-1}, leaf length, number of leaves plant^{-1} recorded high phenotypic and genotypic coefficients of variation, indicating that genotypes had broad genetic base for these characters. The same observations were recorded by Chattopadhyay *et al.* (2013) [4] and Shukla *et al.* (2006) [16] for leaf yield plant^{-1}, Anuja and Mohideen (2007) [3] and Anuja (2012) [2], for number of leaves plant^{-1} and leaf area, Akaneme and Ani (2013) [1] for plant height, Pan *et al.* (2008) [10] and Hasan *et al.* (2013) [6] for stem thickness. 1000 seed weight, days to 50% flowering and days to germination exhibited moderate phenotypic and genotypic coefficients of variation suggesting the existence of moderate variability in the genetic stock studied. Similar findings were reported by Sarker *et al.* (2015) [12] for various traits.

Characters which possessed moderate to high coefficients of variation suggested that there is better potential for improvement through selection. A wide range of variability along with high estimates of phenotypic and genotypic coefficients of variation further indicates that these attributes would respond well to selection.

Heritability (b.s.) was high for all the characters and ranged from 88 to 99 per cent indicating that the characters are less influenced by environmental effects and that characters are effectively transmitted to the progeny. This suggests the major role of genetic constitution in the expression of a character and thus selection based on phenotypic expression could be relied upon. High heritability was also reported by Varalakshmi and Pratap Reddy (1997) [18] for most of the characters; Chattopadhyay *et al.* (2013) [4] for plant height, number of leaves plant^{-1}, stem thickness, leaf yield plant^{-1}; Shukla *et al.* (2006) [16], for number of branches plant^{-1}, leaf area; Akaneme and Ani (2013) [1] for days to 50% flowering; Hasan *et al.* (2013) [6] for leaf length; Anuja and Mohideen (2007) [3] for petiole length, leaf area.

All the characters showed the high estimates of heritability coupled with high genetic advance as per cent of mean, indicating the preponderance of additive gene action for control of these traits. This suggests that real progress in improvement through selection could be made for yield. These results are in conformity with work of several workers *viz.* for leaf yield plant^{-1}, number of leaves plant^{-1}; Shukla *et al.* (2006) [16] for leaf are; Pan *et al.* (2008) [10] for leaf length; Anuja (2012) [2] for plant height, petiole length; Akaneme and Ani (2013) [1] for days to 50% flowering and Mobina *et al.* (2013) [9] for inflorescence length.

Leaf yield plant^{-1} is an important character, which decides the commercial viability of the hybrid/variety. Thus the trait deserves the highest priority in any breeding programme. High heritability along with high genetic advance as per cent of mean for this trait suggested the possibility of selecting high yielding cultivars from the present collection.

Table 1: Estimates of range, environmental variance, phenotypic variance, genotypic variance, environmental, phenotypic and genotypic coefficients of variation, heritability (bs) and genetic advance (as% of mean) for different characters in Vegetable Amaranth (*Amaranthus* spp.)

S. No.	Parameters	Range	Environmental variance (EV)	Phenotypic variance (PV)	Genotypic variance (GV)	Environmental coefficient of variation (ECV)	Phenotypic coefficient of variation (PCV)	Genotypic coefficient of variation (GCV)	Heritability (bs)	Genetic advance (as% of mean)
1.	Days to germination	12.00-23.00	0.99	10.46	9.475	6.21	20.17	19.19	0.90	37.61
2.	Plant height (cm)	59.66-302.99	7.36	2232.38	2225.02	2.49	43.48	43.41	0.99	89.28
3.	Stem thickness (mm)	1.98-23.96	0.31	42.67	42.35	4.49	52.22	52.03	0.99	106.78
4.	No. of branches plant^{-1}	6.50-31.40	0.80	34.52	33.72	6.57	43.19	42.69	0.97	86.92
5.	No. of leaves plant^{-1}	50.20-170.33	11.05	1095.91	1084.85	3.27	32.55	32.39	0.99	66.38
6.	Leaf length (cm)	2.69-15.51	0.11	7.99	7.88	3.84	32.71	32.48	0.98	66.45
7.	Leaf area (cm^2)	4.51-68.42	0.74	265.63	264.89	3.56	67.13	67.04	0.99	137.91
8.	Petiole length (cm)	1.81-10.29	0.10	4.20	4.10	7.22	46.76	46.19	0.97	94.02
9.	Days to 50% flowering	15.16-52.22	0.90	42.25	41.34	3.05	20.83	20.60	0.97	41.99
10.	Inflorescence length (cm)	2.32-44.34	1.33	150.29	148.96	6.60	70.08	69.77	0.99	143.09
11.	Lateral spikelet length (cm)	0.45-30.14	0.47	37.38	36.90	11.24	99.78	99.14	0.98	202.93
12.	1000 seed weight (g)	0.72-1.63	0.00	0.05	0.05	7.40	21.61	20.30	0.88	39.29
13.	Leaf yield plant^{-1} (g)	6.44-53.82	2.63	104.16	101.53	7.40	46.58	45.99	0.97	93.54
14.	Leaf yield (q ha^{-1})	10.73-89.68	7.32	289.32	282.00	7.41	46.60	46.00	0.97	93.57

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